Deciphering the Physics of Supernova Remnants

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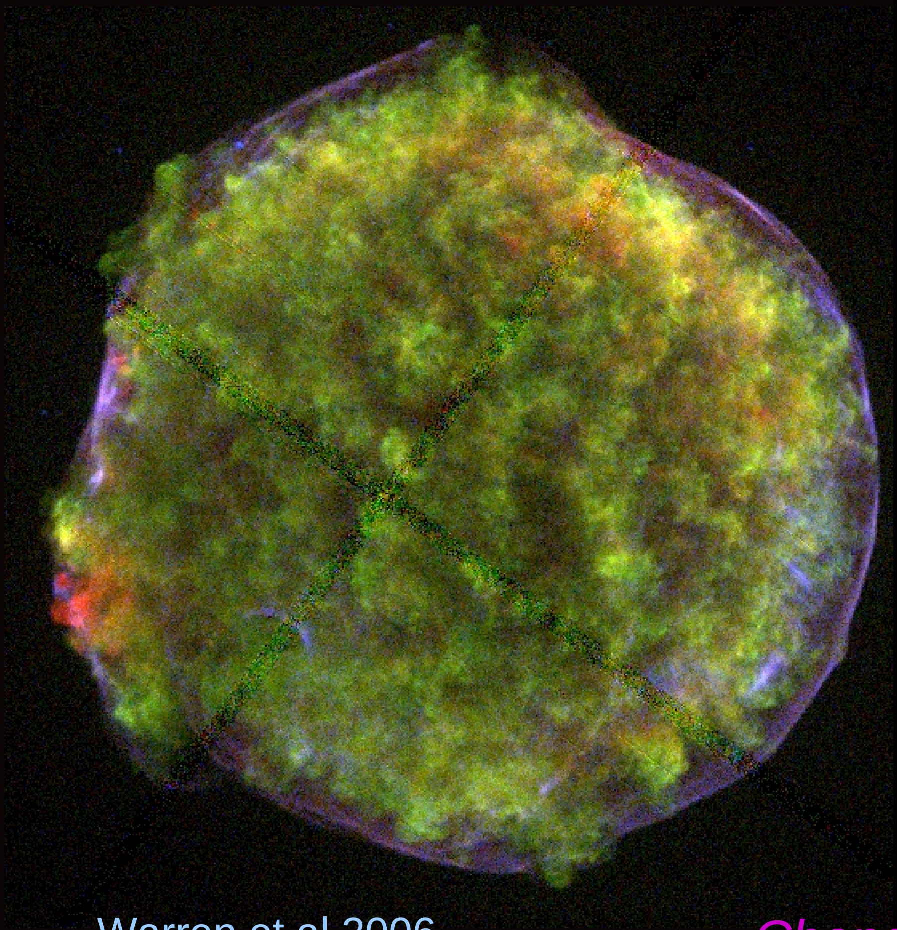
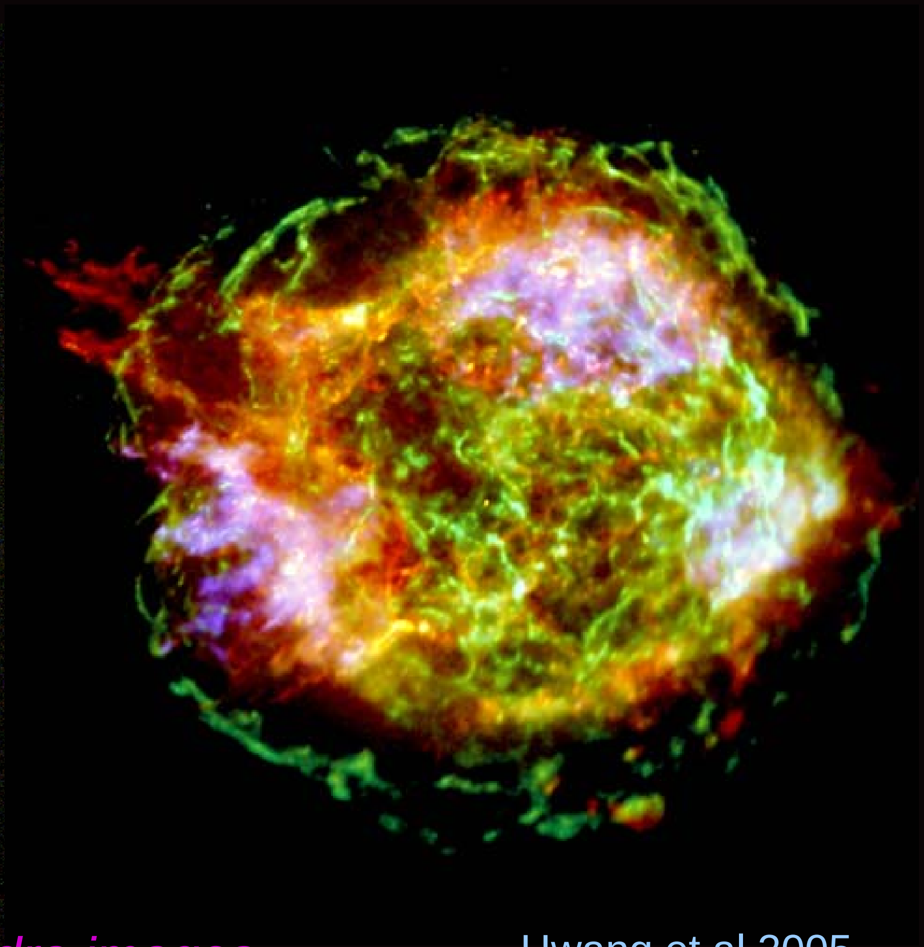
Constellation X Facility Science Team Meeting

February 15, 2006

Deciphering the Physics of Supernova Remnants with Constellation X





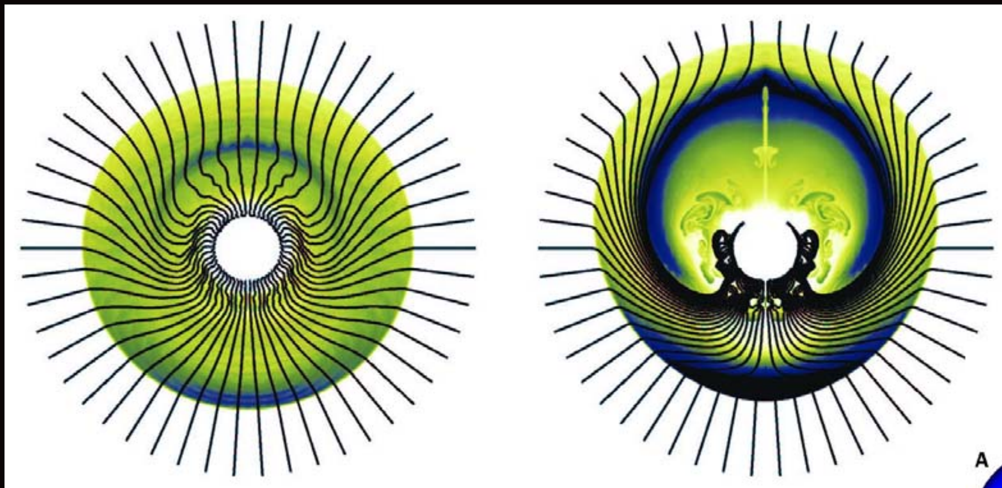
Warren et al 2006

Chandra images

Hwang et al 2005

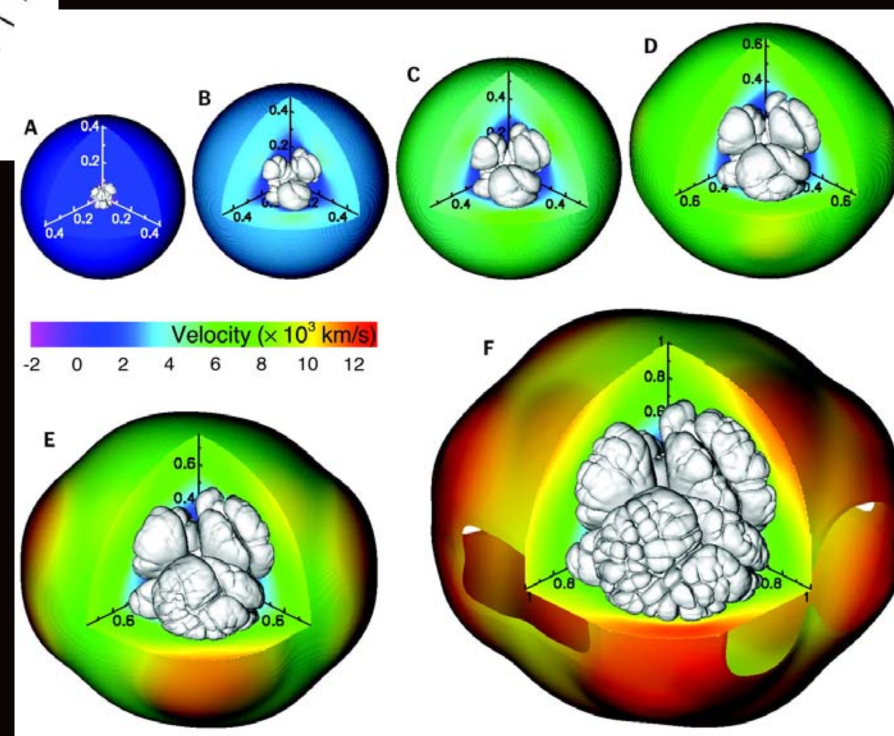
Core-Collapse

and Type Ia



Blondin & Mezzacappa 2006

Gamezo et al 2003

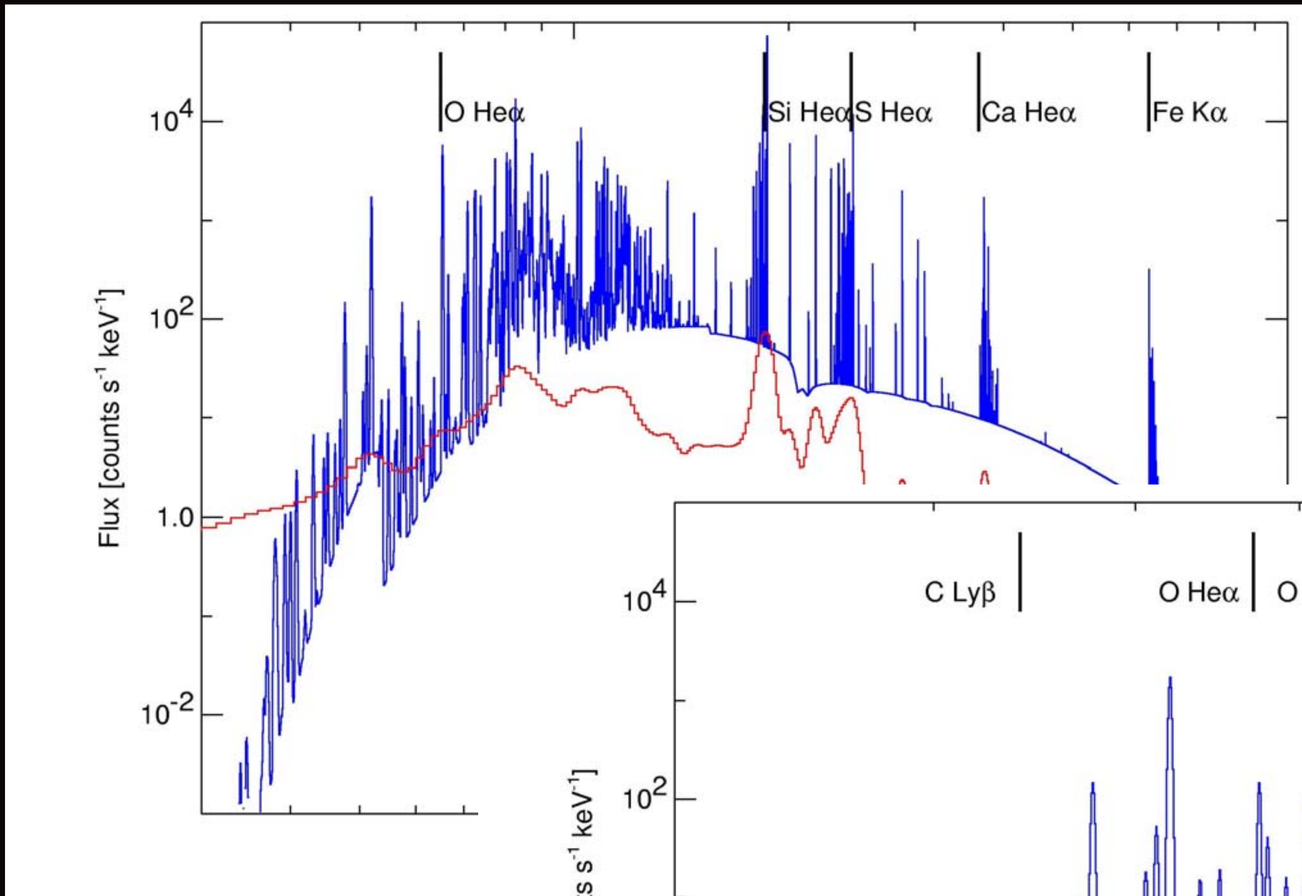


- increasingly sophisticated simulations
- MHD, 3D, rotation, neutrino transport, shock physics, nuclear burning…

Supernova Remnants: Forensics of an Explosion

- X-ray observations of reverse-shocked ejecta
- temperature, ionization, velocity
  - disentangle plasma conditions from true composition and explosion dynamics (Badenes et al. 2003)
  - thermodynamic state of each element independently
- rare elements in the Fe-group, V, Cr, Mn, Co
  - reveal conditions at the heart of the explosion
  - Y_e, entropy, density, temperature

  (for instance, C/O ratio of Type Ia progenitor)



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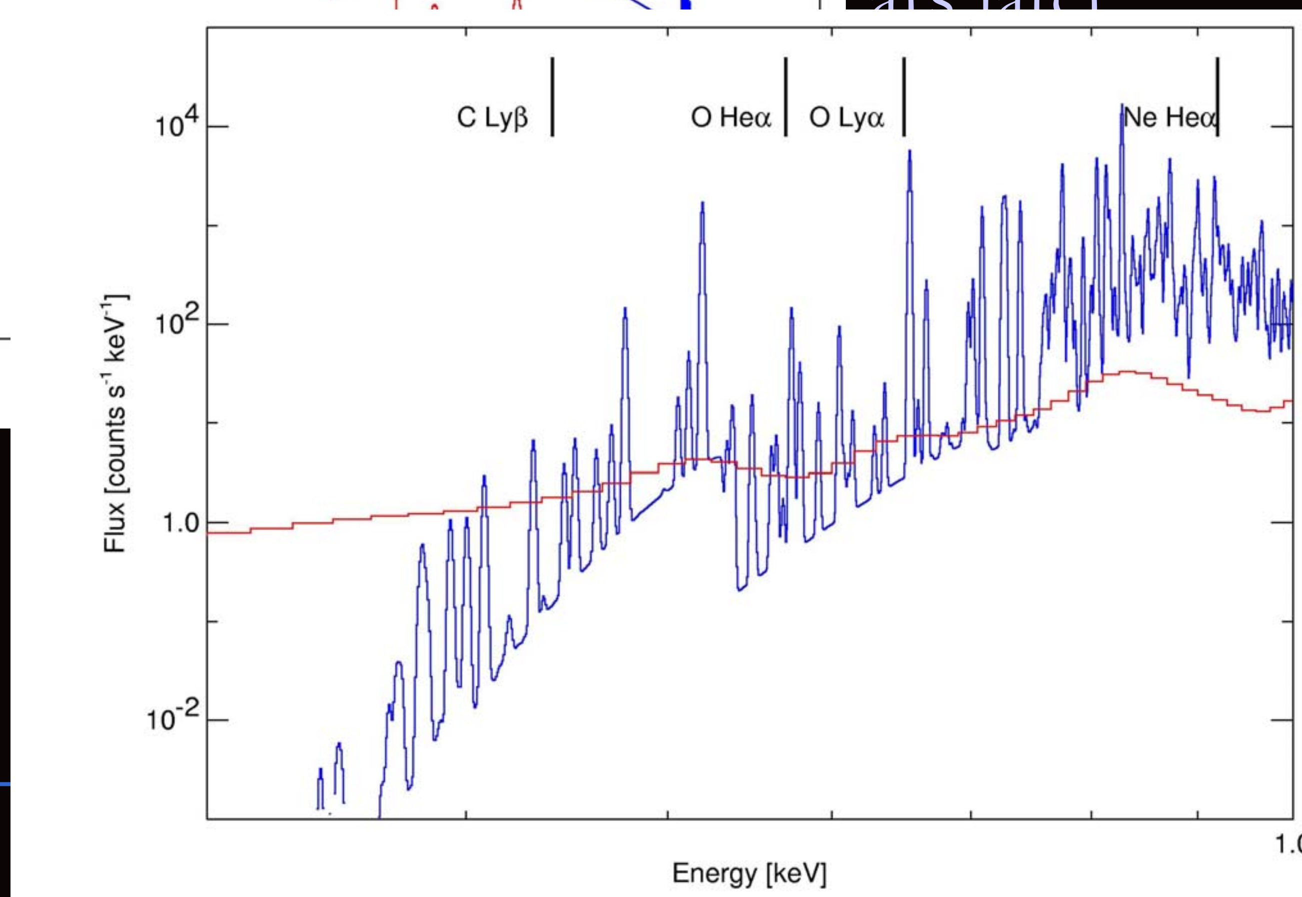
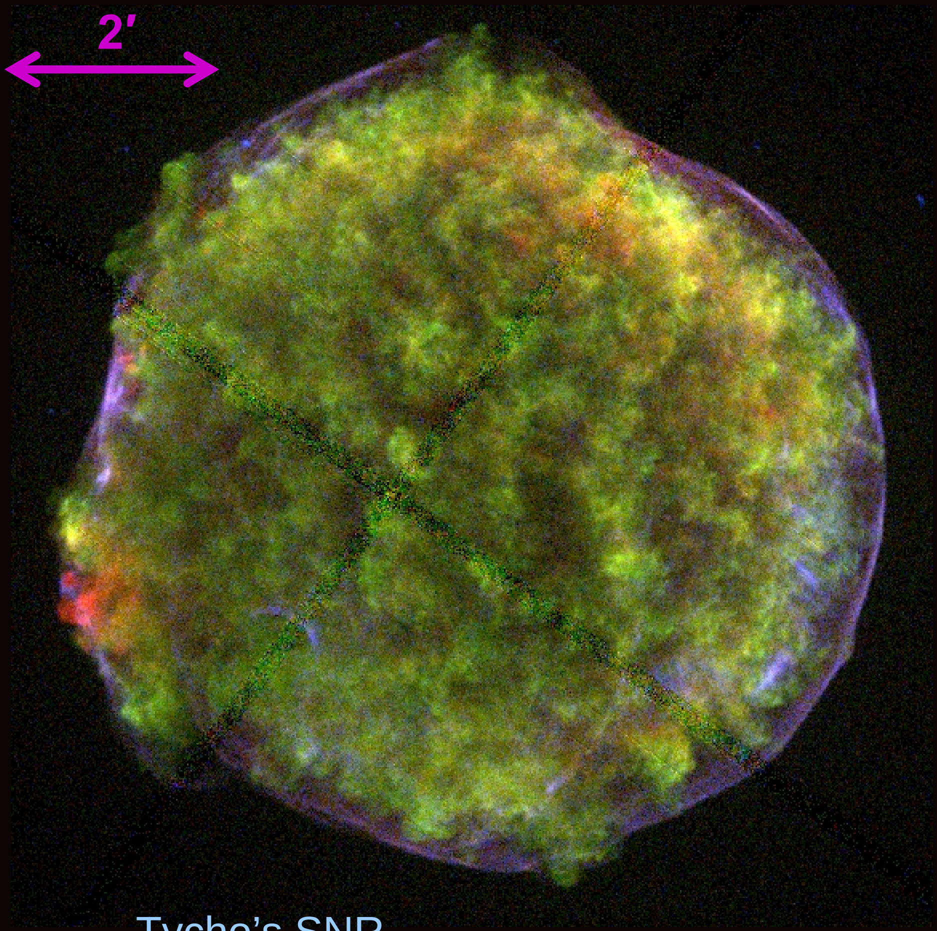
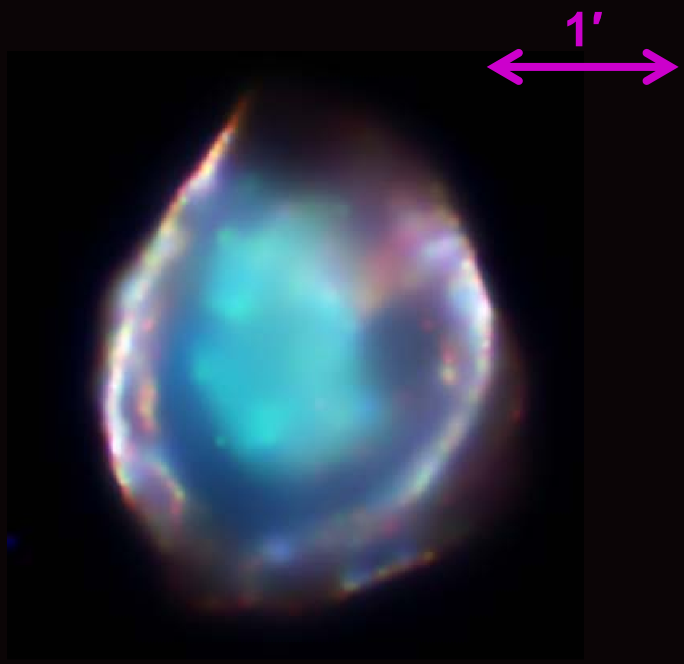


C. Badenes

Type Ia Supernova Remnants



Tycho's SNR



SNR DEM L71 (Large Magellanic Cloud)

Requirement	Value	Topic (most constraining)
SXT Point spread function	5" or less	Cas A, LMC SNRs, diffuse Galactic emission, X-ray halo distances, Galactic center knots
Spectral resolution (nondispersive)	<2eV for E<8 keV	Velocities, line broadening
Spectral resolution (dispersive)	R>1000 (3000 optimal)	ISM/IGM absorption
Non-X-ray background (>1.5 keV)	at or below the level of the unresolved cosmic X-ray background	Abundances in large SNRs, Galactic and MC diffuse emission
Effective Area	Current baseline	Limited to studying SNRs in galaxies no more distant than M31 and M33
High count rate capability	3000 counts/s from 2.5' square region	Bright portion of Cas A with baseline effective area

Abbreviated (see end of slides)

continues…

Requirement	Value	Topic (most constraining)
Field of view	At least 5 times the area covered by an unresolved source. Should not come at the expense of effective area or spectral resolution.	Sufficient to subtract local background from unresolved sources.
Raster scans, mosaicing, large numbers of multiple pointings	Must be implemented efficiently	Nearly all studies
HXT effective area	Extend band to beyond ~80 keV	Detect ^{44}Ti from young Galactic SNRs
HXT point spread function	1 arcmin	^{44}Ti in young Galactic SNRs, X-ray synchrotron emission
HXT field of view	no smaller than SXT	^{44}Ti in young Galactic SNRs, X-ray synchrotron emission

Abbreviated (see end of slides)

… continued

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Non-X-ray background (>1.5 keV)	at or below the level of the unresolved cosmic X-ray background	Abundances in large SNRs, Galactic and MC diffuse emission
Effective Area	Current baseline	Limited to studying SNRs in galaxies no more distant than M31 and M33
Effective Area (nondispersive, E<0.5 keV)	500 sq-cm at 0.15 keV	Diffuse Galactic emission
High count rate capability	3000 counts/s from 2.5' square region	Bright portion of Cas A with baseline effective area

Requirement	Value	Topic (most constraining)
Field of view (Detector area)	At least 5 times the area covered by an unresolved source. Should not come at the expense of effective area or spectral resolution.	Sufficient to subtract local background from unresolved sources.
Raster scans, mosaicing, large numbers of multiple pointings	Must be implemented efficiently	Nearly all studies
Sky coverage for transient source follow-up	>50% of the sky at any one time	Early time emission from SN Ia (allows ~2 SN observations over 5 yr)
Rapid response	<2 days	Detect or limit presence of circumstellar gas in SN Ia (within 4 days of ignition)
HXT effective area	Extend band to beyond ~80 keV	Detect ^{44}Ti from young Galactic SNRs
HXT point spread function	1 arcmin	^{44}Ti in young SNRs, X-ray synchrotron emission
HXT field of view	no smaller than SXT	" "
Event timing accuracy	100 microseconds	Pulsars